



Bellcomm

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from: S. C. Wynn

subject: Computer-Generated Views Showing Surface
Brightness Variations of the Descartes
Landing Area from the LM During Descent
Case 310

MEMORANDUM FOR FILE

In Reference 1, computer generated views of the Descartes landing area representing the region visible to the Commander and the LM Pilot just after high gate and low gate were presented. In these views the relative brightness of the surface features is due to variations in line density and does not correspond to the actual brightness variations of the scene. A method has been developed to approximate the brightness variations across the surface (see Reference 2).

Figures 1 through 8 show the figures from Reference 1 shaded to represent the relative brightness in the region visible to the Commander and LM Pilot just after high gate and low gate for two different sun elevations, 7° and 18°. The computer program used to shade the scenes represents the surface by a series of triangles and assigns to each triangle a brightness value using the photometric function (Reference 3) which is dependent on the angular relations between the normal to the triangle, the sun and the observer (see Figure 9). The triangle is plotted in perspective with the shade of grey in Figure 10 corresponding to the brightness value. The various shades of grey are obtained on the Stromberg-Carlson 4020 plotter by varying the character type plotted, the exposure time of the character on the photo sensitive paper and the proximity of adjacent characters.

The outlines of the LM windows, modified to include the portions of the LM body obstructing vision, are superimposed on the figures. Cylindrical projections were used since planar projections produce distorted images for wide angles of view. Ideally, the figures should be mounted on the inside of a cylinder and viewed from within. The observation point for Figures 1 to 4 was 5660 feet above the landing site (9°00'01"S, 15°30'59"E) and 12,960 feet directly east. The observation point for Figures 5 to 8 was 630 feet above the landing site and 2010 feet directly east.





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The curved horizon appearing in the figures results from the attitude of the observer relative to the scene. The observer is assumed to be oriented with the axis of his head and neck perpendicular to a line from the landing site to his eye. As he scans the scene across the window his head rotates about this axis. Since this axis is about 22 degrees off vertical the horizon drops off as he looks towards the North or South from West. The limit of the data, about 12 km West of the observer, can be seen in Figures 1 to 4. The true horizon would appear higher in the window and increase the apparent curvature. Figures 5 to 8 show a horizon quite close to the true horizon as the observer is at a lower altitude.

2013-SCW-jab

S. C. Wynn

Attachments

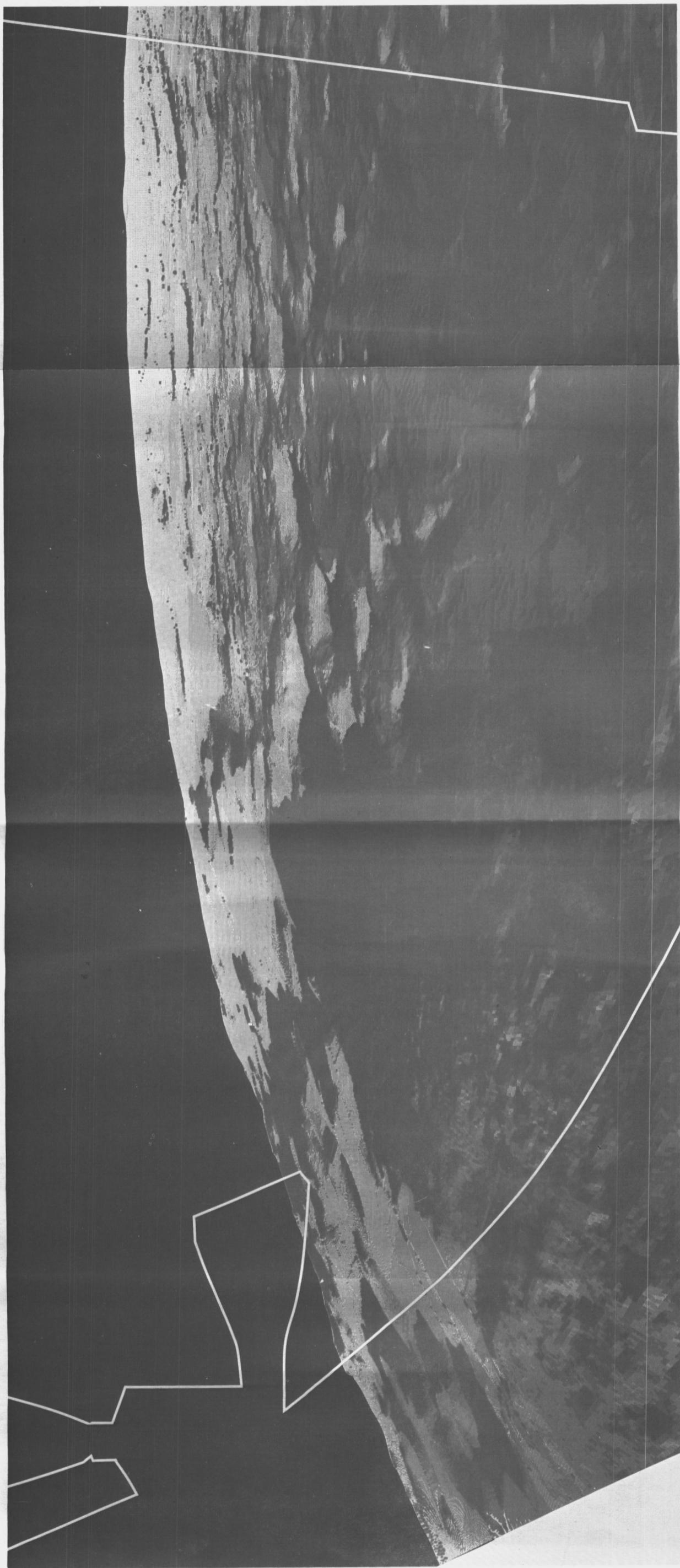


FIGURE 1 - COMMANDER'S VIEW OF DESCARTES LANDING AREA FROM HIGH GATE FOR A 7° SUN ELEVATION
(FROM 5660 FEET ALTITUDE, 12,960 FEET EAST OF LANDING SITE)

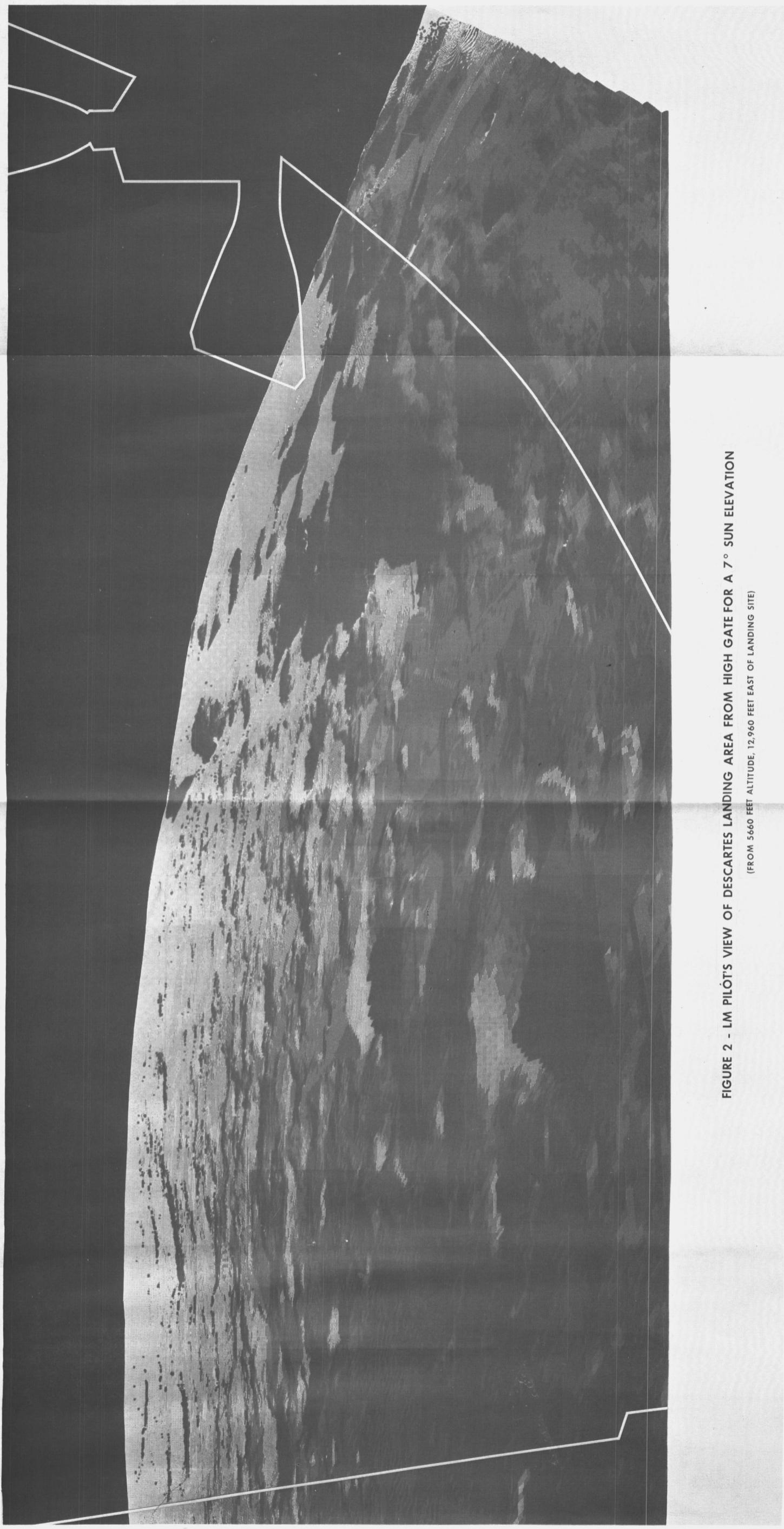


FIGURE 2 - LM PILOT'S VIEW OF DESCARTES LANDING AREA FROM HIGH GATE FOR A 7° SUN ELEVATION

(FROM 5660 FEET ALTITUDE, 12,960 FEET EAST OF LANDING SITE)

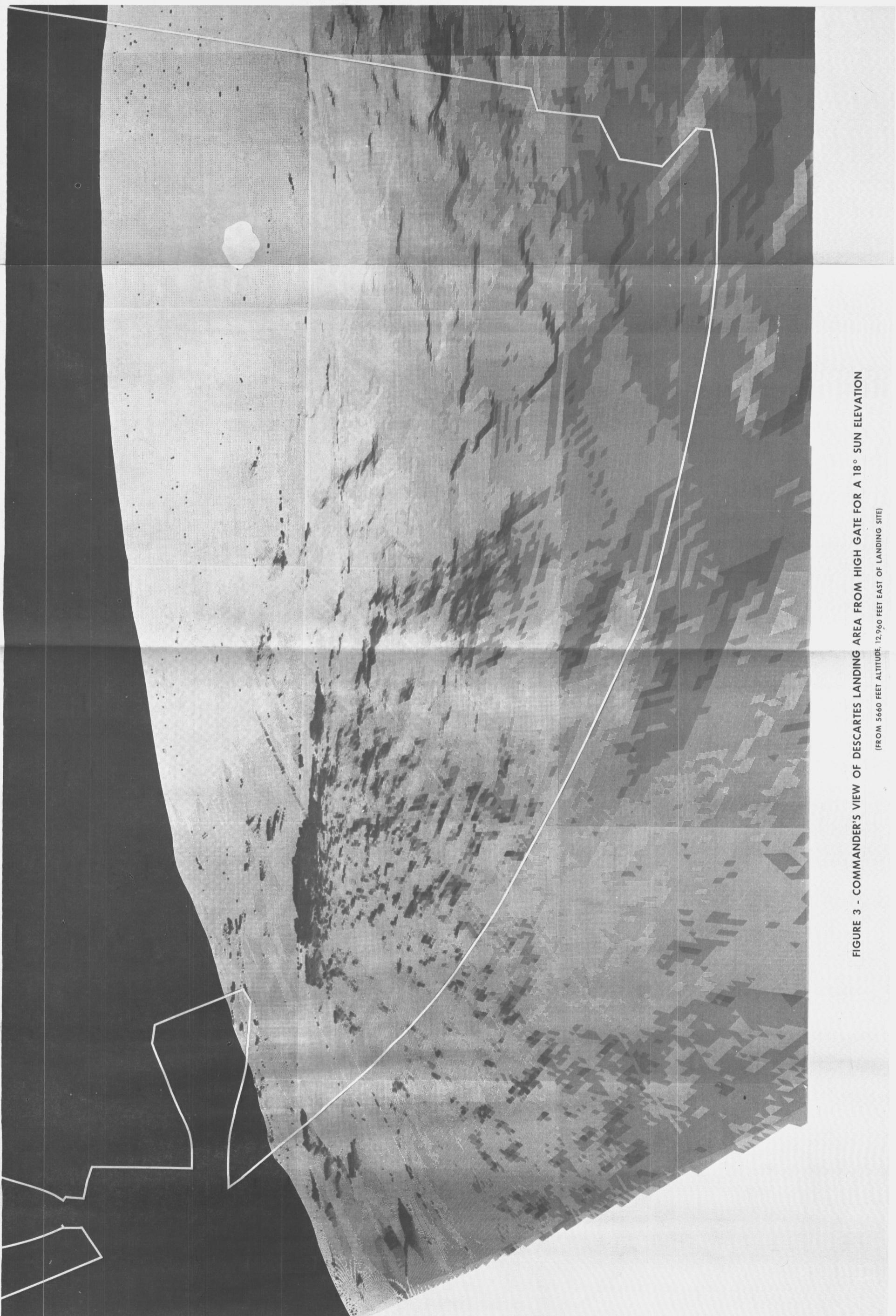


FIGURE 3 - COMMANDER'S VIEW OF DESCARTES LANDING AREA FROM HIGH GATE FOR A 18° SUN ELEVATION

(FROM 5660 FEET ALTITUDE, 12,960 FEET EAST OF LANDING SITE)

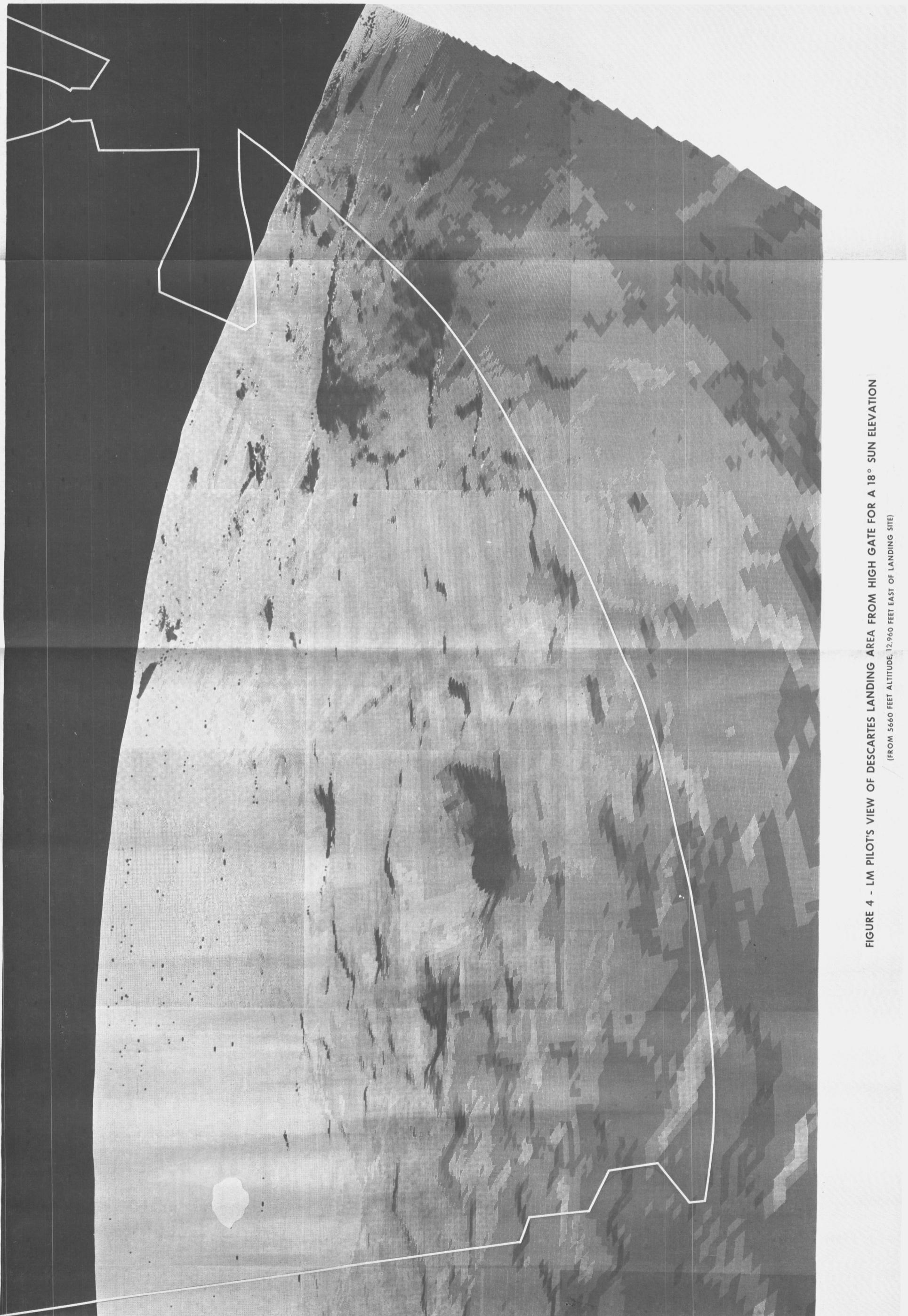


FIGURE 4 - LM PILOT'S VIEW OF DESCARTES LANDING AREA FROM HIGH GATE FOR A 18° SUN ELEVATION
(FROM 5660 FEET ALTITUDE, 12,960 FEET EAST OF LANDING SITE)

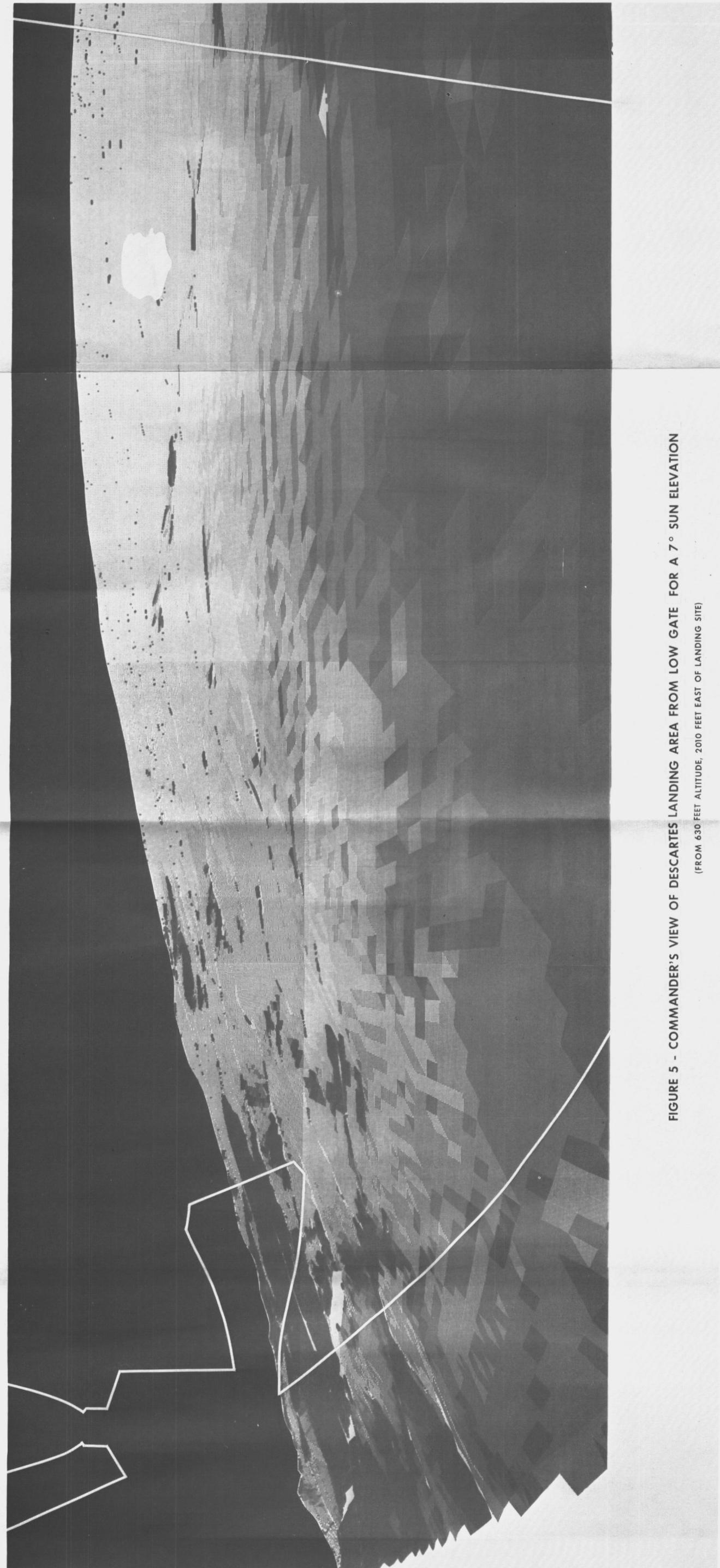


FIGURE 5 - COMMANDER'S VIEW OF DESCARTES LANDING AREA FROM LOW GATE FOR A 7° SUN ELEVATION

(FROM 630 FEET ALTITUDE, 2010 FEET EAST OF LANDING SITE)

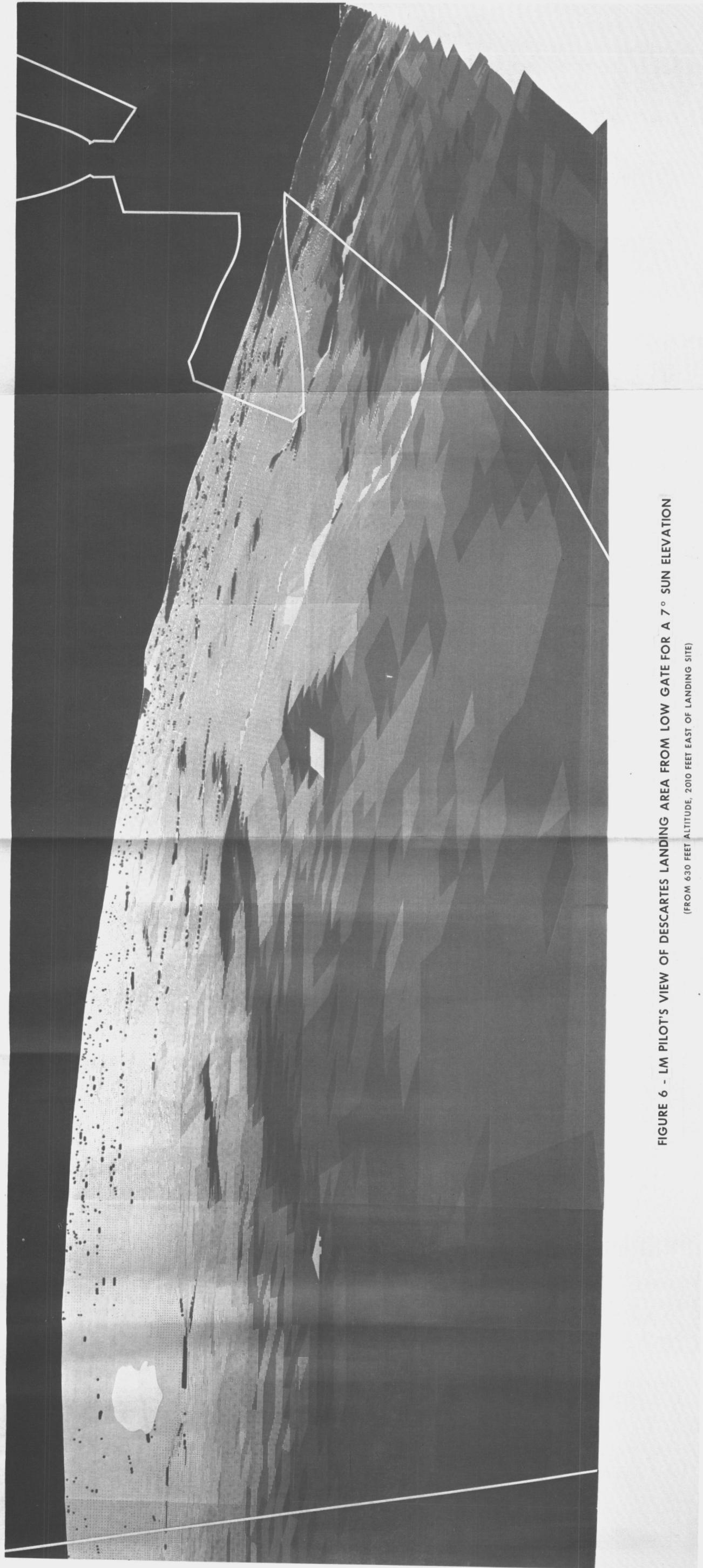


FIGURE 6 - LM PILOT'S VIEW OF DESCARTES LANDING AREA FROM LOW GATE FOR A 7° SUN ELEVATION

(FROM 630 FEET ALTITUDE, 2010 FEET EAST OF LANDING SITE)

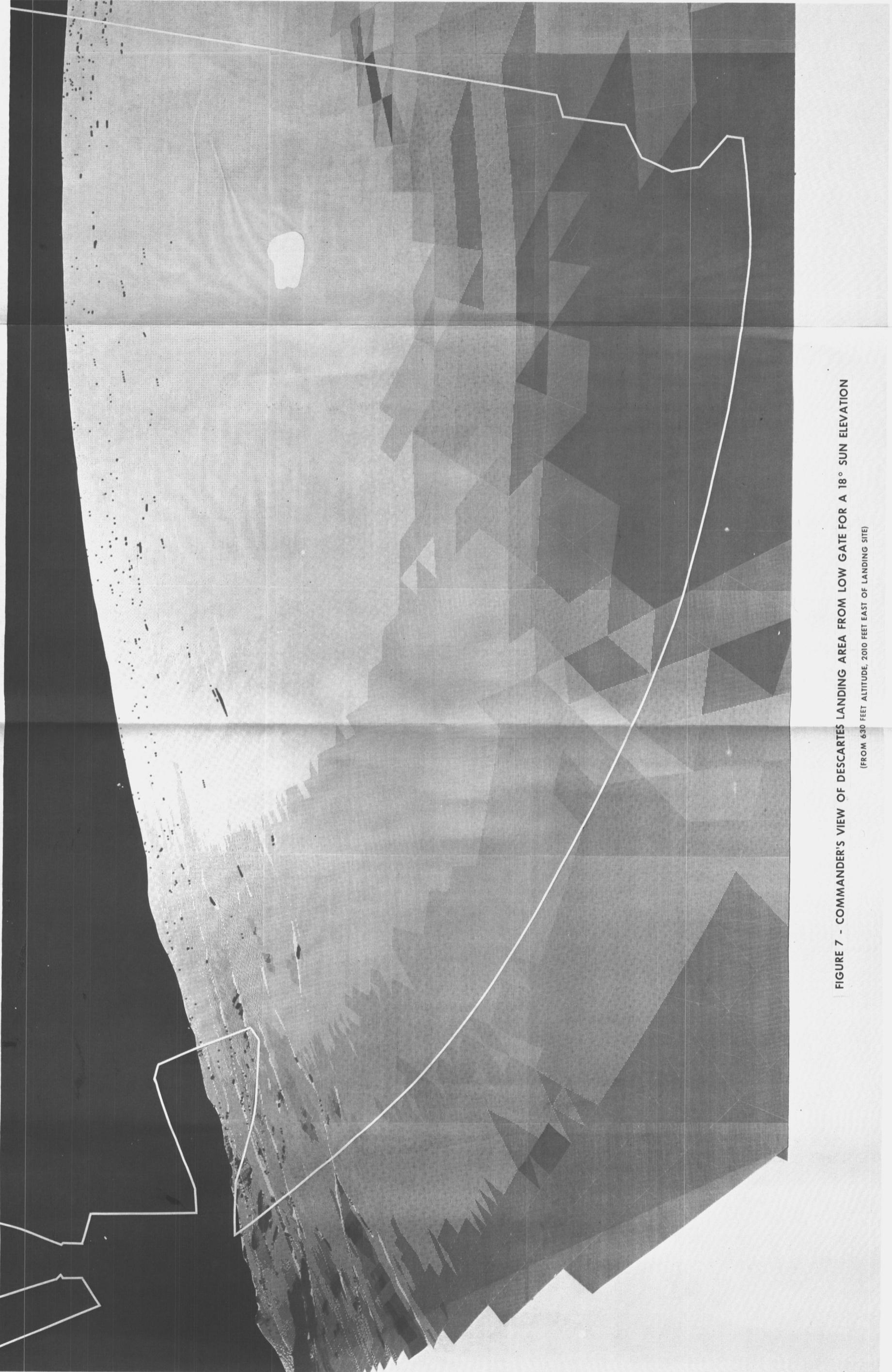


FIGURE 7 - COMMANDER'S VIEW OF DESCARTES LANDING AREA FROM LOW GATE FOR A 18° SUN ELEVATION

(FROM 630 FEET ALTITUDE, 2010 FEET EAST OF LANDING SITE)

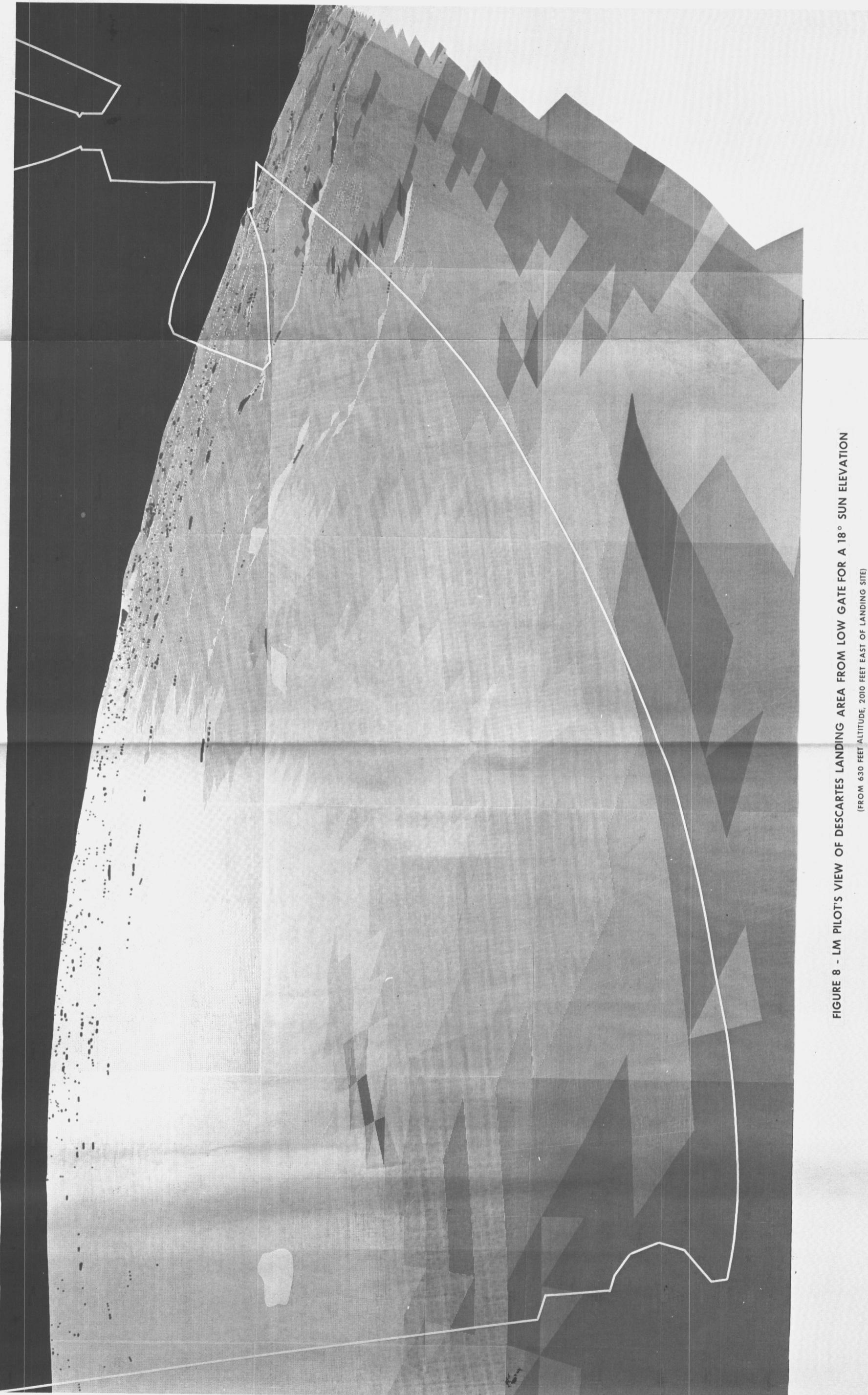


FIGURE 8 - LM PILOT'S VIEW OF DESCARTES LANDING AREA FROM LOW GATE FOR A 18° SUN ELEVATION

(FROM 630 FEET ALTITUDE, 2010 FEET EAST OF LANDING SITE)

\vec{s} VECTOR FROM CENTROID OF TRIANGLE TO SUN
 \vec{o} VECTOR FROM CENTROID OF TRIANGLE TO OBSERVER
 \vec{n} NORMAL TO THE PLANE OF THE TRIANGLE
 \vec{p} COMPONENT OF \vec{n} THAT IS IN THE PLANE DEFINED BY \vec{s} AND \vec{o}

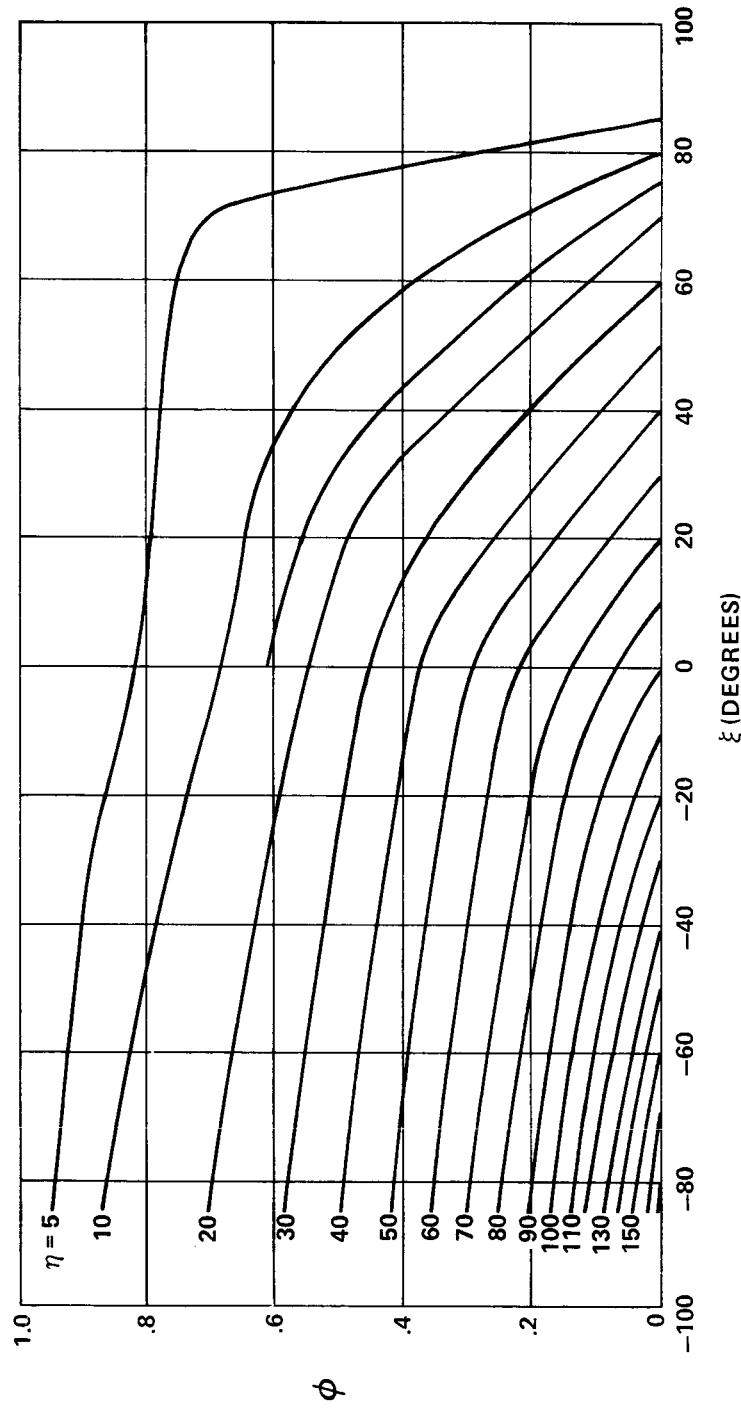
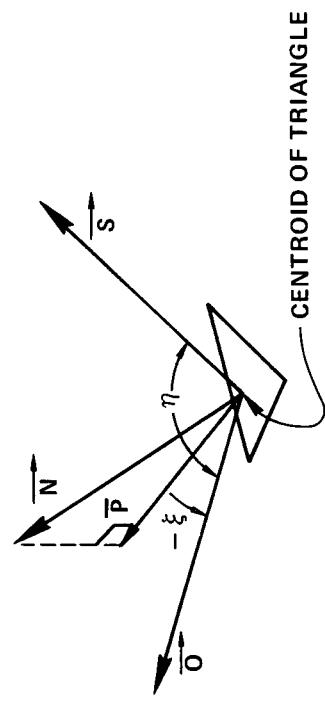


FIGURE 9 - PHOTOMETRIC FUNCTION ϕ

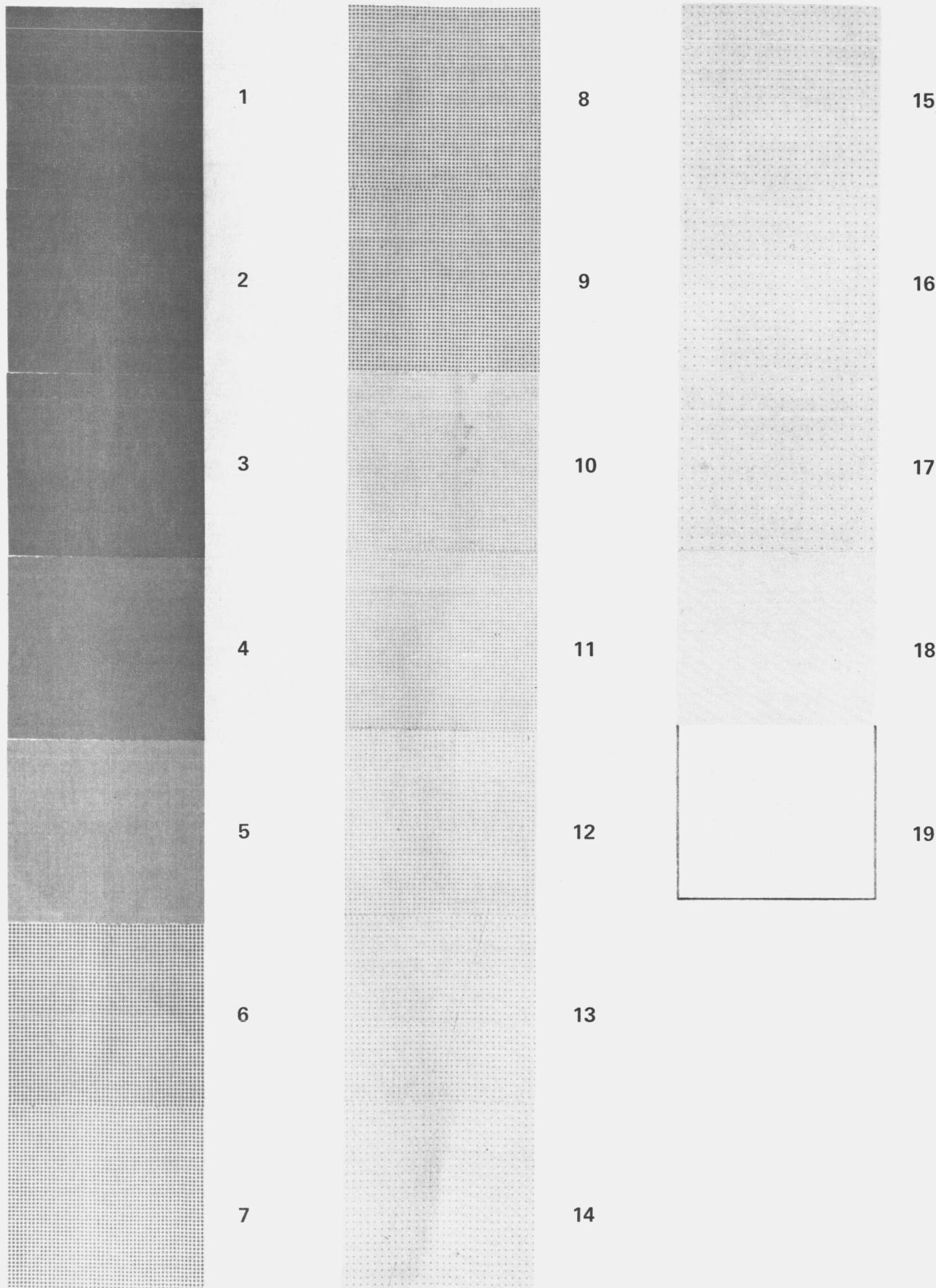


FIGURE 10 - SAMPLES OF THE GREY SCALE



Subject: Computer-Generated Views Showing
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From: S. C. Wynn

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REFERENCES

1. "Two Computer-Generated Views of the Descartes Landing Area from the LM During Descent," Bellcomm Memorandum for File B72-01007, Case 310, S. C. Wynn, January 19, 1972.
2. "TOPORAMA's Shading Program," Bellcomm Memorandum for File (to be published), Case 310, S. C. Wynn.
3. "The Lunar Reflectivity Model for Ranger Block III Analysis," Jet Propulsion Laboratory Technical Report No. 32-664, D. Willingham, November 2, 1964.